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The vse of the two Mathematicall instruments, the crosse Staffe, (differing from that in common vse with *the mariners:*) *And the Iacobs Staffe: Set* foorth Dialogue wise in two briefe and plaine Treatises: the one most commodious for the Mariner, and all such as are to deale in Astronomicall matters: the other, profitable for the Surueyor, to take the length, height, depth, or breadth, of any thing measurable.

Set forth by Th. Hood. mathematicall Lecturer in the Citie of London.

Newly reviewed, and the second time imprinted.

The Staues are to be sold in Marke lane, at the house of FRANCIS COOKE.

Imprinted at London by Richard Field for Robert Dexter. 1596.

TO THE RIGHT HONORABLE, CHARLES LORD HOWARD, BARON OF EFFINGHAM, LORD HIGH ADMIrall of England, &c.

WHen I preſented this little booke in writing vnto you (right Honourable) I did little thinke that it ſhould haue come vnto the Printers hand: but the Staffe being ſhewed vnto diuerſe men that were deſirous to know the vſe thereof, I thought the labour would be too long to teach euerie one, and to write it out continually, the pains would haue bin much more. Therefore to ſaue both my paines in writing, and my labour in teaching, I could finde no better meanes, then to commit it vnto the preſſe. Conſidering then that it muſt abrode, I beſeech your Honour, that it may appeare vnder your name, that as it pleaſed you at the firſt to giue it a friendly entertainment, ſo now you would alſo be Patron vnto the ſame, that your authority protecting, and your wiſdome allowing it, you may ſtay the vnaduiſed cenſure of ſome raſh conceipted men. Wherby I ſhalbe both encoraged to a further ſtudy, and bound to pray for your Honours increaſe in all good things.

Your Honors moſt humble,

Thomas Hood.

To the courteous Reader.

I Preſent vnto thee (gentle Reader) in one ſmall Volume, the vſe of two Mathematicall Inſtruments, the one is the Croſſe Staffe: the other, the Iacobs Staffe. In the deliuery of their vſe, I haue done mine endeuour to lay out the matter moſt plainely, that thou maiſt finde commodity in the thing. That is all my deſire, which if I may attaine vnto, I ſhall be glad. If any thing ſeeme otherwiſe vnto thee, accept my good will, whoſe purpoſe was to ſatisfie thy minde: and interprete hereof fauourably, at the leaſt, becauſe it is my firſt labour that euer came abroad. So ſhall I be the more willing to take farther paines, and to commit ſuch other things vnto thy ſight, as I haue in hand. Farewell.

Thine *Th. Hood.*

A Dialogue touching the vſe of the Croſſe Staffe.

Scholler.

HAuing vnderſtode that you haue a kinde of Croſſe Staffe, ſomewhat differing from thoſe of the common ſort, I am ſomewhat bold to requeſt a litle conference with you about the ſame.

Maiſter. Not ſo bold as welcome: It is my deſire to further all men what I can. I pray you therefore briefly to propound what you would haue, and I will returne an aunſwer to your contentation, ſo farre forth as I may.

Sc. Firſt, I deſire to know, what end you haue generally in the thing.

Ma. The Staffe may be vſed to diuerſe purpoſes: but my chiefeſt end and intention therein, is to take the height of the Sunne aboue the Horizon.

Sc. May not a man do it as well by the other Staffe, commonly which is called Bella Stella?

Ma. Compariſons are odious, therefore I omit that matter, and requeſt you to propound ſome other queſtion. Yet this I ſay, that this Staffe is not ſo troubleſome as that, which you haue named. Moreouer, the degrées thereof are greater then thoſe of the other Staffe, though the Staues themſelues be of equall length. For 5. of them are as bigge as 15. in the Bella Stella. Neither are you tied vnto an Horizon: for it may be vſed both by land and ſea: and without applying it vnto your ſight.

Sc. Theſe be no ſmall commodities. If therefore I may

obtaine at your handes the vſe of this Staffe, I ſhall thinke my ſelfe not a litle beholding vnto you.

Ma. Your requeſt is graunted: Take therefore what order you thinke beſt for your inſtruction.

Sc. Becauſe I would haue all things plainly delinered, I will keepe this order in my queſtions. Firſt, I wil begin with the two peeces of wood: and then with the ſockets: thirdly, I will requeſt the vſe of the Vane: and laſt of all, howe the Sunnes altitude may be found out.

Ma. Do ſo: and I will labour to fulfill your mind.

Sc. Firſt therefore, what names doe you giue vnto theſe two peeces of wood?

Ma. I call the one the Yard, the other the Tranſame.

Sc. What meane theſe markes that are in them?

Ma. They are degrees of altitude, with their minutes.

Sc. But how ſhall I diſtingniſh the Tranſame from the Yard, ſeeing the degrees in them both be all of one quantitie, neither hath the one of them any more degrees then the other?

Ma. It is true that there be 45. degrees in each of them. The Tranſame containeth the firſt, namely, all the degrees from 1. to 45: the Yard containeth the reſt, namely, the degrees from 45. vnto 90.

Sc. Is that of neceſſitie that they ſhould do ſo?

Ma. No: But by this meane I make the degrees ſo great as they are.

Sc. Then I perceiue this: that from the ryſing of the Sunne, vntill he be rayſed 45. degrees aboue the Horizon, his elevation muſt be taken in the Tranſame. Againe, after that he is 45. degrees aboue the Horizon, his elevation muſt be taken in the Yard.

Ma. It is ſo.

Sc. May I eaſily knowe by this ſtaffe, when the Sunne is vnder 45. degrees, and when he is aboue 45. degrees of elevation?

Ma. Yeſt

Ma. Most easily, and readily: as you shall be taught hereafter.

Sc. Why is the yard cut off so close vnto the 90. degrée?

Ma. That it may the better come vnto your sight: wherein the Centre of the circle is imagined from whence all the lines do come.

Sc. Thus much concerning the Transame, and the yard. Now for the Sockets: to what purpose serue they?

Ma. They be made to ioyne the Transame and the yard together.

Sc. What principall note is to be obserued in them?

Ma. They must be ioyned together squire wise, at right angles,

Sc. To what end are the notches in them?

Ma. The notches serue to this purpose, to see how to set the Transame, and the yard iust vppon his place. For the brasse carying a certaine thickenesse with it, doth hinder my sight so, that I cannot well iudge of the true place whereon they should stand, were it not for these notches, which must bee no deeper, then the thickenes of the brasse, or if they be deeper, they must be both of one depth.

Sc. To what end serue the Screws?

Ma. They serue to none other purpose but this, namely, to keepe the Sockets fast in their places that they slip not.

Sc. May I put the Sockets vpon the yard which way so euer I will, without any difference?

Ma. No: But you must take heede of this, that the Socket wherein the Transame must be put, must alwaies hang downeward, for so it is best: otherwise there is not any great heede to be taken. And yet for auoiding of confusion, let this be your rule, that The end whereat your two Sockets close together, be next vnto your sight.

Sc. To what end serueth the Vane?

Ma. It serueth to take the elevation of the Sunne, and also to saue your sight from the beames thereof.

Sc. In what maner I pray you?

Ma. Of that I will enforme you hereafter: for the maner being diuers, cannot wel be set down here, without confusion.

Sc. Whereupon must the Vane stand?

Ma. Sometimes vpon the Transame, and sometimes vpon the Yard, according as the manifold vse of the Staffe requireth.

Sc. Is it any matter to which hand it standeth? either to the right hand, or to the left?

Ma. Yea that it is: and this Rule shal alwayes serue your turne, When the Transame standeth on the right hand of the Yard, let the Vane bend toward the left hand: and contrariwise, when the Transame standeth on the lefte hand of the Yard, let the vane bend toward the right hand.

Sc. Now let me know how I shall ioyne the Transame and the Yard together: for to that end were the brazen sockets made.

Ma. They are to be ioyned together diuersly, according as the Staffe is diuersly vsed.

Sc. Is the staffe then to be vsed after more waies than one?

Ma. Yea, for you may chose whether you will apply it vnto your eye (as you do the Balla stella) or whether you will holde it in your hand, and find the height of the Sunne by the shadow of the Vane.

Sc. Is there any generall obseruation to be noted in these seuerall vses?

Ma. Yea: For this is a generall rule, that whether you apply it vnto your eye, or whether you holde it in your hand, the Transame must be alwaies perpendicular vnto the Horizon, and the yarde leuell vnto the same.

Sc. But how shall I be assured of the perpendicularitie and the parallelitie of the one and the other?

Ma. At the Sea, where your Horizon is fre if you bring the Yard euen with the closing of the heauen & the Horizon,

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it is enough: But vpon the Lande, or loking out at a Windowe of an house, or standing in the stréete, you may adioyne vnto the one side of your Transame a Plummet of Leade, thereby to finde out his perpendicularitie. Yet do I not thinke that so necessary, because I know, that a little practise will make the eie a reasonable iudge both of the perpendicularity, and of the parallelitie.

Sc. Let vs now come vnto the particular vse of the Staffe. You say that in séeking out the elevation of the Sunne, I may chuse whether I will set the Staffe vnto mine eie (as I do the Bella stella) or whether I will hold it in mine hand.

Ma. It is so.

Sc. I pray you therefore instruct me first concerning the vse of that, when I must set it vnto mine eie.

Ma. This one thing is not to be neglected, that it must stand on the ball of your chéeke, for that place is most conuenient, because it doth not lightly yéelde, neither is the sight thereby disturbed: Yet if any man thinke it méeter to apply the Staffe to the corner of his eie nert to the eare, I will not gainesay him, because the sight is not to euery man so ready in one place as it is in an other.

Sc. How must I in this case ioyne, the Transame and the Yard together.

Ma. Put the Yard into his socket, so that the notch may stand iust vpon the 45. degree. Then put the Transame into his socket in like manner, that the notch may be vpon the 45. degree.

Sc. Is it not materiall which waies the degrées stand, either vpward or downeward, or on the side?

Ma. Let this be your rule: Keepe the degrees of the Yard vpward, and let the degrees of the Transame be toward you, so shall you be the lesse deceiued. Otherwise to them that are cunning, it is neither here nor there.

Sc. Is there any thing to be obserued in the placing of the Vane, more then hath beene said before?

Ma. This is to be noted, that the edge of the Vane must be placed iust with the highest degree of the Transame.

Sc. Each thing being fitted in this maner, how shall I take the height of the Sunne?

Ma. First, you must know whether the Sunne bee more or lesse then 45. degrees aboue the Horizon.

Sc. How shall I know that quickly? for me thinketh that should be troublesome.

Ma. It is most easie. The Transam and the yard being ioyned together, as you haue beene taught: turne the 90. degrees of the yard toward your breast (it is no matter for setting it vnto your eie) and bring the Transame right against the Sunne, vntill the shadowe thereof fall euen with the side of the yard. If the shadow of the Transame from the toppe of the Vane downward be longer then the yard, it is a most certaine signe that the Sunne is vnder 45. degrees high. If it be shorter, the Sunne is more then 45. degrees high.

Sc. If the Sunne be lesse then 45. degrees high, what must I do?

Ma. Set the Staffe close to your eye, keeping the yard parrallele vnto the Horizon, as you haue beene taught before: then let the Transame sinke downe into his socket, vntill the toppe of the Vane come euen with the Centre of the Sunne, the number of the degrees from the top of the vane to the notch of the Socket will declare his eleuation.

Sc. This thing is plaine enough. May not his eleuation yet be found out any other way by the Transame, while the Sun is vnder 45. degrees.

Ma. It may be found out otherwise in this manner: Put that end of the Transame into his Socket, which conteyneth the beginning of the degrees, let the first degree come euen with the notch, as the 45. degree did before, and make the Transame fast with the scrue: then set the yard vnto your eie, and keeping it leuel, moue the Vane vp and downe, vntill the vppermost edge thereof come euen with the Centre of the

Sunne

Sunne: the degrée vppon which it lighteth is the Sunnes altitude.

Sc. Thus much concerning the Sunne whiles he is vnder 45. degrées. What must I do to finde his altitude being aboue 45. degrées?

Ma. The Yard, Transame, and Vane being orderly placed, as it was taught before, set the yard vnto your eie, and keeping it leuel, draw the Transame to you ward, vntill the Vane be euen with the Centre of the Sunne: the degrée then of the yard, vpon which the notch of the socket lighteth, declareth vnto you the height of the Sunne.

Sc. Is there any more to be sayde concerning the vse of the Staffe, when it is applied vnto the eie?

Ma. No: For I haue at large declared the same: so that now it remaineth to tell you, how the Staffe may be vsed, although it be not applied vnto the eie.

Sc. One thing let me first demaund: May not I take the height of any starre in the same manner as I haue taken the height of the Sunne?

Ma. Yes, that you may: Neither is there any difference in the one from the other. You may also take the distaunces of any two starres thereby, so that they be not further alunder then 90. degrées, following the selfe same precepts which you haue bene taught concerning the Sunnes altitude. For if the two starres be lesse then 45. degrées alunder, they will be within the end of the Transame, and the yard. Then set the yard against the one starre, and draw the Transame into his socket, vntill the edge of the Vane light vpon the other starre, and the degrées of the Transame will shew their distaunce. If the two starres propounded be more then 45. degrées alunder, it is certaine, that they will be without the compasse of the Transame. Then draw the Transame towarde your sight, vntill the end of the yard light vpon the one starre, and the edge of the Vane vppon the other starre, and the degrées of the yard will shew their distaunce, so that you may take the

diſtance of any two ſtarres that are 90. degrées aſunder.

Sc. Now let vs returne vnto the former queſtion: how muſt the Tranſame and the Yard be ioyned together, and how muſt the Vane be placed, if I be not diſpoſed to ſet the ſtaffe vnto mine eie?

Ma. The ioyning of them, is after diuerſe maners, according as the vſe doth differ. Firſt, you may find the ſunnes elevation in the ſame maner, as you did before, although you do not apply the ſtaffe vnto your eie, and therefore in this caſe the Tranſame and the Yard muſt be ioyned together, as they were before, and the Vane muſt alſo ſtand after the ſame manner.

Sc. How then ſhall I finde the Sunnes elevation?

Ma. Set the palme of your hand cloſe to the end of the Yard where the 90. degrée is placed, and then turne the Tranſame vpon the Sunne, and pull downe the Tranſame into the ſocket, vntill the ſhadow of the toppe of the Vane fall iuſt vppon the end of the Yard cloſe to your hand: Then the degrée of the Tranſame next vnto the ſocket, is the Sunnes elevation.

Sc. I perceiue that in this caſe alſo I muſt hold the yard very leuell.

Ma. Yea, that you muſt: and ſo ſhall you be ſure of the Sunnes altitude.

Sc. May I finde the Sunnes elevation thus, if he be more then 45. degrées high?

Ma. Yea, euen as you did before. For this is all the difference, that your hand ſtandeth now in ſtead of your eie And I am of this minde, that if you take héede vnto the leuell of your yard, you may take the Sunne as preciſely this way, as you do with applying the ſtaffe vnto your eie. Beſides, this is one commodity, you ſhall not dazell your ſight, and hurt it as you did before.

Sc. What other way is there yet to vſe the Vane, and how muſt I ioyne the Tranſame and the yard together?

Ma.

Ma. There is yet an other way to finde out the height of the Sunne without ſetting the ſtaffe vnto your eie. For the performaunce of which concluſion, you muſt ſet the yard and the Tranſame together thus. Put the Tranſame into his ſocket ſo, that the beginning of the firſt degrée may fall iuſt with the notch: then make it fall with the ſcrue: put the yard also into his ſocket, in ſuch ſort that the 45. degrée fall euen with his notch, and ſet the Vane at the other end of the yard, as you were inſtructed before.

Sc. How muſt I vſe it then?

Ma. You muſt here alſo haue that conſideration which you had before of the Suns eleuation, whether he be more or leſſe then 45. degrées, which is knowen by the rule giuen in the beginning.

Sc. If the Sunne be leſſe then 45. degrées high, how muſt I hold the ſtaffe?

Ma. Let the Tranſame hang downeward toward your féete, and turne the Vane which is vpon the yard to the ſunne vntill the ſhadow of ỹ yard fall iuſt with the ſide of the Tranſame: the degrée of the Tranſame, vppon which the ſhadow of the Vane doth fall, declareth the height of the Sunne.

Sc. Is it materiall which ſide of the ſhadow I do chooſe?

Ma. Yea, For that ſide of the ſhadow muſt be choſen, which is made by that part of the Vane, which is next vnto the end of the yard, as you may ſée in the figure.

Sc. I perceiue your meaning in this. But how muſt I hold the ſtaffe, if the Sunne be more then 45. degrées high?

Ma. Then muſt the Tranſame lie leuell with the Horizon, which before did hang perpendicular, and the yard muſt ſtand vpright toward your Zenith. Then turne the yards toward the Sunne ſo, that the ſhadow thereof fall cloſe to the ſide of the Tranſame, marke vpon what degrée of the Tranſame the ſhadow of the vppermoſt ſide of the Vane falleth, ſubduct that out of the 90. degrées, and the remainder ſheweth the Sunnes eleuation.

Sc. May not the height of the starres bee found out in this manner?

Ma. No: By reason their beame is so weake that it cannot cast a shadow; but the beame of the sunne being so strong, his height may thus be easily found out, and very readily, and also certainely, having onely this care, that the staffe be kept leuell as it ought to be.

Sc. Is there any thing else to be saide concerning the vse of this staffe?

Ma. It may be vsed to diuerse other purposes (as I said in the beginning:) namely, to the description of Regions, and Countries: to the finding out of the quantities of the Eclipses of the Sunne and Moone: with the longitude and latitude of the Planets. This staffe also serueth to the correcting of the places of the fixed starrs: & to the setting downe of the amplitude of the rising or setting of the Sunne or Starrs. But mine intent was onely to take the Sunnes elevation therwith. Yet haue I told you how to take the altitude of the starrs with their distances, by the same staffe: which for this time shall suffice. The other propositions I will lay forth, either in my publike lectures which I read, or at other more conuenient time, as my leysure serueth.

FINIS.

THE VSE OF THE IACOBS STAFFE.

Imprinted at London by
Richard Field, for Robert
Dexter. 1596.

TO THE RIGHT HONORABLE, L. IOHN LVMLEY, BARON OF LVMLEY. &c.

AFter that I had penned (Right honorable) the vſe of the Croſſe ſtaffe, I was deſired by mine acquaintance, to take the paines in the Iacobs ſtaffe. I did ſo: my paines were liked and called (as the former) vnto the preſſe. Without a Patrone I would not haue it come forth, becauſe I would not be thought to bee without a Patrone. To rrouble one man with them both, I thought it not good, leaſt I ſhould ſeeme forgetfull of other my well-willers: among whom your good will, ſhewed vnto me at diuerſe times, hath emboldened me to craue your patronage for the thing, which if it ſhall pleaſe your Honour to vndertake, I ſhall accompt it as a ſpeciall token of your louing fauour, and acknowledge my ſelfe in recompence, bound to pray for your Honours daily encreaſe in all kindes of bleſſings.

Your Honours moſt
humble. Th. Hood.

A Dialogue touching the vſe of *the Iacobs Staffe.*

Scholler.

SInce my laſt departure from you, I haue diligently applied the croſſe Staffe, according vnto the rules which you haue preſcribed, and finde the ſame to be very conuenient for the purpoſe, which you haue ſet downe: that is, for the taking of the height of the Sunne and Starres, with their diſtances: Yet can I not ſtay my ſelfe here, but muſt once againe preſume vpon your courteſie.

Maiſter. What is it that you deſire? I loue not many words, but you ſhall find me moſt ready to pleaſure you, or any man els, as far forth as my ſimple skill will afford me.

Sc. This is the matter: I would gladly learne the vſe of the Iacobs Staffe as well as I haue learned the vſe of the croſſe ſtaffe: May I not therefore ſo deuide the croſſe ſtaffe on the one ſide, that it may ſerue my turne for a Iacobs ſtaffe, ſo that I be not troubled with the cariage of any more then one?

Ma. Yes, very well. And loe, here is one ſo diuided, that as the one ſide of the Yard and Tranſame ſerueth for the Sun and Starres, ſo the other ſerueth for any dimenſion.

Sc. This falleth out euen as I would haue it: ſeeing therefore the Staffe is ready at hand, if your leyſure ſerue, I pray you inſtruct me in the vſe thereof.

Ma. With a good will: Moue you the queſtions, and I will anſwere them.

Sc. Why doe they call it Iacobs Staffe? Was he the firſt inuentor of the thing.

Ma. I know not that: but they take occasion to call it so, by reason of those wordes which are written Gen. 32. 10. where the Patriarch sayth, *That with his Staffe he came ouer Iordane:* Wherein I thinke, they misconstrue his meaning. Notwithstanding, by whom soeuer it was inuented, the Instrument questionlesse is of singular vse.

Sc. Let that passe, and declare I pray you, what affinity this Staffe hath with the other. For comparisons will make a thing more plaine.

Ma. First, as in the other Staffe, the degrées of the Yard and Transame are all one in number, so are the partitions in this. Secondly, as the yard and Transame in that, did ioyne together squarewise and at right angles, so must they doe in this. Thirdly, there must the same consideration be had in placing of the Vane in this, that was had in the placing of the Vane in the other: that is, it must stand euen with the beginning of the partitions, except some speciall occasion require otherwise, as is to be séene in the measuring of breadthes. Fourthly, One of the two, either the Yard or the Transame, as occasion serueth, must be parallele vnto the thing measured, the other must be perpendicular.

Sc. Is that a rule to be noted in the Iacobs staffe?

Ma. Yea that it is: otherwise it is most certaine you commit an errour.

Sc. Then haue I béene amisse informed, as I haue séene men, that haue thought them selues to be of no small cunning in the vse of the Staffe, who measuring the height of a thing, haue made no matter how they held their Staffe, so that they did sée the toppe and the bottome of the thing to be measured, euen with the two ends of their Transame.

Ma. Beléeue me in this, that it cannot be that their practise should be true. This one argument shall serue for a thousand. You know that the proofe of the vse of the Iacobs staffe standeth vppon the proportion of Triangles. Now those Triangles onely are proportionable which are like, and in like ma-

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ner ſituated, which they can neuer be except either the yard, or the Tranſame be parallel or perpendicular (as occaſion ſerueth) to the thing meaſured.

Sc. Your reaſon is good that it ſhoulde be ſo: but me thinketh that the performaunce thereof ſhould bee impoſſible.

Ma. Why ſo?

Sc. You know that many Fields be full of Dales and hollow places: others be full of Hilles and Mountaines. Moreouer, many things ſtand not vpright vpon the ground, but leane either forward or backeward, or elſe to the one ſide or to the other. Laſt of all in the breadth of a thing there is a great variety. For be it in a wall, or fielde, or what elſe whatſoeuer, there is for the moſt part either hollownelle or roundnelle, or ſome ſuch like thing which may make it impoſſible in my iudgement to draw either parallele or perpendicular line vnto them.

Ma. I graunt thoſe things to bee as you ſay: yet doe they not hinder a man from taking the meaſure of their length, height, or breadth. For where the place it ſelfe doeth not affoorde a leuelneſſe: it is an eaſie matter to imagine it leuell. Thus alſo you muſt thinke with your ſelfe, that although Geometry bee the Arte of meaſuring well, and generally nothing may be excluded from the compaſſe thereof, yet muſt we not bee too curious in particulars, leaſt we ſhew our ſelues either ouer wiſe, or elſe too foliſh. The Phiſitian generally profeſſeth to heale all diſeaſes, but when he commeth to deale with particular bodies, he faileth in his art, and yet is not to be diſcommended ſo long as he doeth that which Art requireth. It is enough for the Geometrician, if he giue the iuſt length of a ſtreight line drawen betweene two places aſſigned. Or if hee can not doe it by one ſtreight line, he may doe it by many. Whoſoeuer immediately (for mediately he may finde out the length of a croked line by meanes of a ſtraight line)

whosoeuer, I say, requireth any more of him then that, he abuseth both the man and the art. Therefore, when any thing is propounded to be measured, be it length, height, or breadth, you are first of all to consider, whether the thing lie leuell, or stand vpright, or be straight, as it is required that it should be. If it be straight, you may presently fall in hand to measure it, as your rule shall direct you: If it be not straight, but be either crooked, or leaning one way or another, it must be your principall care, first to fit the same to your purpose: as for example, in measuring the distance of a thing (for I will first begin with that dimension, and will afterwards teach you what you shall doe in the rest) if the distaunce betwéne two places assigned be not straight, as you see in these figures which follow it is not, then chose out two points in the distance, the one being at the one end thereof, and the other in the other, betwéne which you may imagine a right line to be drawen, and then so hold your Staffe, that the yard or the Transame may be parallele, or perpendicular vnto it, as occasion shall serue.

Sc. You haue throughly satisfied me in this. Tell me now wherein these staues do differ, séeing you haue declared wherein they doe agrée.

Ma. Their difference consisteth in two things especially: in their partitions, and in their vse.

Sc. Touching the first difference, it is euident indéed, that the parts of the other Staffe are vnequall, and that this is diuided into equall portions: but maketh it any matter howe many the parts are into which this Staffe is deuided?

Ma. No: The more the better, and more precise will your worke be. And therfore, if you could diuide them into 100000. it were the more commendable, but 1000. sufficeth in this Staffe, which though it be not deuided into more, yet you may imagine it to be an hundred times as much as it is.

Sc. What is the difference in the vse of the Staues?

Ma. The generall difference is this: the other serueth for Astronomicall matters: this serueth for measuring of land.

Sc. What

Sc. What meane you by those words, Measuring of land? Is it to take the breadth, or length only of a field: or may it be applied otherwise?

Ma. The truth is this, that by this Staffe we may measure the length, the height, and the breadth of any thing, all the which we expresse by those words, Measuring of land: having relation to the word Geometry, which signifieth the same if it be construed word for word.

Sc. Before I doe come vnto the particular measuring of these three dimensions, length, height, and breadth, what generall notes haue I to obserue?

Ma. First, that whether the Yard or the Transame be applied vnto your sight, it must stand close vnto the ball of your cheeke.

Sc. But which end of the Yard or Transame must stand to the sight ward?

Ma. That which hath the beginning of the degrees: for so it is most conuenient for the readinesse of your account. The second note is this: to winke with one eie. For the sight by that meanes will aime at your marke the better, when it is not parted but brought into one. The third obseruation is this: that, the distance of your marke be not ouer great.

Sc. Why do you giue this note, considering that in the vse of the other Staffe, there was no limitation made of any distance? For you measured therewith the starres in heauen.

Ma. The case is not all one, because the Starres haue a brightnesse which helpeth their sight, and their beame commeth directly from the Centre of their body, vnto our eye. But in terrestriall things it is not so: For in them, by reason of the weaknesse of our sight, we may be greatly deceiued, except they be within a reasonable compasse.

Sc. What do you call a reasonable compasse, or distance?

Ma. It cannot well be defined, because there are so many things required therein, that they will hardly iumpe all together generally: as these, the clearenesse of the aire: the good-

nesse of the sight: the largenesse of the instrument. The aire may be cleare, but the sight of a man may be dull. Againe, the sight may be quicke enough, but the aire may be thicke. Againe, both the aire and sight may serue the turne, but the instrument which he is to vse may be so small, that he can not take any thing farre distant from him. So that we cannot generally determine of the distance otherwise then thus, saying that that is a reasonable distaunce, which is proportionable both to our instrument and sight.

Sc. Proceede I pray you in the matter wherein you were.

Ma. The fourth regard must be had vnto your hands that they be steddy. For otherwise you may misse of the proportion of your measure. The last note is this, to take heede vnto the place wherein you make your station.

Sc. How shall I be sure of that?

Ma. Thus: You know this, that either you stand vpright, or else leane one way or other. To be short, howsoeuer your situation be, whether it be standing, sitting, leaning, or vpright, that is the place of your station, which is right beneath your eie, so directly as is possible to be iudged and taken.

Sc. These fiue things you say are generally to be noted. 1. The setting of the Saffe at the ball of the eye: 2. The wincking with one eie: 3. A reasonable distance: 4. A steddy hand: 5. The certaine place of your standing. Let vs now come vnto the particular vse of the Staffe in the three dimensions. You say, the Iacobs Staffe serueth to take the length, the height, and the breadth of any thing: Are these dimensions found out any more waies then one?

Ma. Yea: The length, and the height, are found out three seuerall waies, and the breadth two waies. The first and the second way require one station: the last way in each dimension is performed by two stations.

Sc. What meane you by a station? and what is it to performe a thing by one or moe stations?

Ma. A station is nothing else but the place wherein you stand:

ſtand: to performe a thing therefore at one ſtation, is nothing elſe but by a ſtanding in one onely place by the helpe of your inſtrument, to take the meaſure of a thing. To performe it at two ſtations, is by ſtanding in two ſeuerall places to take your meaſure.

Sc. What generall note is there to be obſerued, when we meaſure a thing at one ſtation?

Ma. You know this, that the meaſuring of a thing by the Iacobs Staffe, dependeth wholly vpon proportions, whoſe drift and finall end is this, by three numbers giuen, to find out the fourth. Two of theſe numbers are alwaies the partes of your Staffe, the one being the partes of your Tranſame, the other of the yard: the which numbers muſt be placed according as the rules which follow ſhall direct you. The thirde number of proportion is ſome aſſigned meaſure in this manner. If you meaſure the length of a thing, ſome certaine height muſt be aſſigned. If you meaſure the height or breadth of a thing, ſome certaine length, or diſtance muſt be giuen you for your thirde proportionall number, and this number muſt keepe the third place in the rule of proportion, or Golden rule, or rule of three, as we do commonly terme it. Then muſt we ſay thus: that, as the partes of the Tranſame cutte off by the Yard, are vnto the parts of the Yard cut off by the Tranſame: Or contrariwiſe: As the parts of the yard cut off by the Tranſame, are vnto the parts of the Tranſame cut off by the yard, ſo is the aſſigned meaſure which is giuen you, vnto the meaſure of the thing ſought for. This is the chiefeſt note in meaſuring at one ſtation.

Sc. What note is there to be obſerued in meaſuring at two ſtations?

Ma. There are three things ſpecially to be noted: The firſt is, the making of your ſtations, that they be both of them in a right line with the thing to the which you leuell your ſtaffe, whether you go forward or backward.

Sc. How may that be done?

Ma. Chooſe out ſome marke in the thing to be meaſured, which may be leuell with your eye, then ſet vp two ſtaues where you minde to make your two ſtations, ſo that ſtanding at the further Staffe, you may bring the other iuſt with the marke which you doe chooſe out: ſo ſhall you be ſure that the two ſtations are in a right line with the marke choſen. For it is a generall rule, that if three pointes be in one leuell of the eye, thoſe three pointes are in one right line. The ſecond is, that your eye be no higher at the one ſtation then it is at the other. This is to be done by the rule which I gaue you euen now. For if you, ſtanding at your ſecond ſtation, and holding your Staffe leuell from your ſight, can ſee the top of the Staffe which ſtandeth at your firſt ſtation, and alſo the marke which you chooſe, it is a certaine ſigne that your eye is in his iuſt height. The third note is, that the diſtuance betweene the two ſtations be diligently taken, and that in a right line, ſo neare as is poſſible: becauſe the whole art of meaſuring by the Iacobs ſtaffe, dependeth vpon a right line. This diſtance muſt be the third number of your proportion. And theſe be the chiefeſt obſeruations that I remember. If there be any thing elſe, I will put you in minde thereof as occaſion ſerueth.

Sc. Let vs come now vnto the particular dimenſions, and beginne firſt with the length: What call you the length of the thing meaſured?

Ma. It is the diſtaunce betwéne the place whereon you ſtand, and the place aſſigned, vnto which you direct your ſight: and in this caſe we commonly ſay thus: How farre is it from my foote, to ſuch or ſuch a thing: as a Tree or Houſe, &c.

Sc. Giue me now the rules whereby I may direct my ſelfe in meaſuring any diſtance giuen.

Ma. The firſt rule requireth, that the yard ſhould be perpendicular to the length meaſured: And that is this. The yard of your Staffe being perpendicular vnto the thing meaſured. If your ſight paſſe from the top of the yard ouer the end of the Tranſame to the farther end of the thing propounded, as the

parts

partes of the yard cut off by the Tranſame, ſhall be vnto the parts of the Tranſame cut off by the yard, ſo ſhall the height of him that meaſureth bee vnto the length of the thing propounded.

Sc. Here are two queſtions to be propounded. Firſt, what call you the end of the Tranſame?

Ma. That is generally called the end of the Tranſame, ouer the which your eie ſight paſſeth whereſoeuer it be, whether it be in the very end of the wood it ſelfe, or any other place, where you liſt to ſet the Vane, ſo that your eye ſight paſſe by that place.

Sc. Secondly, what call you the height of him that meaſureth? For ſome man may be, and is a great deale higher then another.

Ma. The height of the meaſure is the diſtaunce betweene the top of the Staffe and the thing meaſured: as in the 1. figure from y. to o. and from a. to o. is the height of the meaſurer: ſo that whether he ſtand vppon the ground at the one end of the diſtance aſſigned, or whether he ſtand vpon ſome higher place, the maner of worke is all one: this being noted as a generall rule: That the height of the top of the yard from the ground, muſt be certainely knowen.

Sc. Expreſſe the meaning of your Rule by ſome example.

Ma. Put caſe the partes of the Yard cut off by the Tranſame bee 60. and the partes of the Tranſame cut off by the Yard be 180. let the height of the Staffe from the ground be 4. foote: then I ſay that as 60. which are the partes of the Yard, are vnto 180. which are the parts of the Tranſame: euen ſo is 4. foote, which is the ſuppoſed height of him that meaſureth vnto the length propounded. So that I conclude the length thereof to be 12. foote.

Sc. This is eaſily concluded, and dependeth, as I remember vpon the 4. p. of the 6. booke of Euclide: where it is ſayed that: In equiangle triangles, the ſides which containe the equall Angles are proportionall, and the ſides which are ſub-

tended vnder the equall Angles, are of like proportion. Wherefore I perceiue (as you told me before) that the third number of the proportion, is the aſſigned height.

Ma. It is true: and you may moſt manifeſtly perceiue that in the Figure which you ſayd concerning Euclides propoſition: For the 2. Triangles a. e. i. and a. o. u. are like, becauſe they are ſituated after one and the ſelfe ſame maner: therfore in the Triangle a. e. i. as a. e. is vnto a. i. ſo in the Triangle a. o u. a. o. is vnto o. u. Thus you ſee the commodity of the Staffe in meaſuring the length of a thing. And here you muſt note this, That it is no matter whether the thing meaſured do lie in a plaine or flat, or whether it be in the aſcention or deſcention of an Hill, or whether there be any concauity or conuexity betweene the ends of the thing meaſured. So that by this rule, we may meaſure the breadth of any Riuer, or of any Trench, or of any Valley betweene the tops of the hils, or the diſtaunce of two Ships at ſea &c.

Sc. The firſt Rule required, that the yard ſhould be perpendicular vnto the thing meaſured. But caſe the yard do lie parallele vnto it, as it is in the 2. Figure, what then?

Ma. The yard being parallele vnto the thing meaſured, if your ſight paſſe from the beginning of the yard ouer the ende of the Tranſame, then, as the parts of the Tranſame cut off by the yard, are vnto the parts of the yard cut off by the Tranſam, ſo is the height aſſigned vnto the length propounded to bee meaſured.

Sc. So then by your Rule I conclude, that if the partes of the Tranſame cut off by the yard be 120. parts: and the parts of the yard cut off by the Tranſame be 210. and the height aſſigned and knowen be 400. feete, the length to be meaſured muſt be 700. feete, as I perceiue by the Golden rule, and by the propoſition of Euclide mentioned before.

Ma. You ſay very true: for conſidering the two Triangles a. u. o. and a. i. e. are like, it muſt needes follow, that as in the leſſer Triangle o. u. is vnto u. a: ſo in the greater e. i.

muſt

must be vnto i. a.

Sc. You sayd heretofore, that there were 3. waies to finde out the length of any thing, whereof 2. are already set downe: What is the third way?

Ma. The two waies already set downe, require but one station. For you are not bound to remoue from the place whereon you first set your foot when you beginne to measure. But this third way requireth a double station, as in the 3. Figure, which is many times necessary, because that a Tree, or a Wall, or an Hill, may be betweene our sight and the end of the thing, whose distaunce from vs we desire to know, so that our sight cannot come vnto the end thereof. The third way differeth from the former in this, that there is no altitude to be assigned and giuen for the third number of the proportion, but the third number of the proportion, is the distaunce betweene the two stations.

Sc. I pray you answere me to this: Considering that I must take 2. stations, at which is it best to begin? Is it best to begin my first station at the end of the distance propounded, and so go backeward? or is it best to begin my first station a good way from the end of the distaunce propounded, and then come forward to make my second station?

Ma. That is neither here nor there: But the common vse is to begin the first station, at the end of the distance propounded, and so go backward: in the which thing doing, you must take heede of that especially, which I told you before, that you goe backeward in a straight line: so that the line imagined to be drawen from the one end of the distance propounded vnto the other, being continued vnto the second station must make but one right line: otherwise you shall erre in your measure more or lesse.

Sc. What distaunce is best to be made betweene the two stations?

Ma. The larger the better: For it is good neuer to take a short station, if you may haue a large one: because your er-

rour will be the leſſe thereby.

Sc. Giue me now the rule which I muſt follow.

Ma. The Yard being parallele vnto the length propounded to be meaſured, and your eye at each ſeuerall ſtation, paſſing from the head thereof ouer the end of the Tranſame, vnto ſomething that ſtandeth vpright, at the farther end of the diſtaunce prounded: as the difference of the greater ſegment of your Tranſame ſhall be vnto the leſſer ſegment: ſo ſhall the length betweene the two ſtations be vnto the diſtance propounded.

Sc. In this kinde of meaſuring, muſt the Tranſame kæpe one place vpon the yard, without pulling it nigher, or putting it farther off from the ſight?

Ma. The rule that I gaue you euen now requireth that it ſhould do ſo. And then you muſt note this, that the farther you go backeward from your firſt ſtation, the lower muſt the Tranſame ſinke into his ſocket.

Sc. Giue me an example of that which you haue ſayd.

Ma. Put caſe that at your firſt ſtation the partes of the Tranſame cut off by the Yard were 108. at your ſecond ſtation, put caſe the partes of the Tranſame cut off by the Yard were 72. imagine alſo the diſtance betwæne your two ſtations were 40. fæte: I muſt ſæke out the difference betwæne the ſeuerall partes of the Tranſame cut off by the Yard: which by ſubduction I finde to be 36. (for that is the remainder, 72. being ſubducted out of 108.) whereupon I conclude thus, that as the difference of the greater ſegment of the Tranſame, namely, 36. is vnto the leſſer ſegment, which is 72. ſo is the diſtance betwæne my two ſtations, to the length propounded: and therfore the length propounded to be meaſured is 80. fæte. For if 36. giue 72. then 40. fæte (which is the diſtance of the two ſtations) muſt needs yæld 80. Thus haue you hitherto ſæne the thræ ſeuerall waies how to meaſure the length of any thing propounded. It followeth now to inſtruct you in taking the height of any thing propounded.

Sc. What

Sc. What call you the height of a thing?

Ma. The height of a thing, is the perpendicular drawen from the top thereof, vnto the base whereon it standeth.

Sc. Then you regard not at all the crookednesse of a thing.

Ma. No: I care not at all for the fashion thereof. For whether it leane forward or backeward, to the right hand or to the left, I care not, so that from the top thereof I may draw down a perpendicular line: as you see in the fourth figure.

Sc. Do you take all this line?

Ma. Your measure taketh no more then is from the leuell of your eie vpward: and therfore this must be a generall rule, that, if the thing propounded to be measured, doe stand leuell with your feete, you must adde vnto the height found out, the height also of your owne stature.

Sc. How many waies is the height of a thing measured?

Ma. Three maner of waies, euen as the length or distance was.

Sc. What must bee the third proportionall number in the first two waies?

Ma. As in the measuring of lengths, the height assigned and giuen, was the thirde proportionall number: so in the measuring of heights, the length assigned is the third number of the proportion.

Sc. Giue me the rules to direct me by.

Ma. The first rule is this: Your Transame making a right angle with the height to be measured: and your sight passing from the beginning thereof to the toppe of the height: as the partes of the Transame cut off by the Yard, are to the parts of the Yard cut off by the Transame, so is the length giuen vnto the height.

Sc. Put case then the parts of the Transame were 60. and the partes of the Yard 36. and the length giuen 20. foote: the height according to the rule must be 12. foote.

Ma. It is so. But you must remember to adde the height of your owne stature: so that it shall be in all 16. foote, or 15. foote

according as you ſhall pleaſe to allow for your owne height.

Sc. Let me requeſt this by the way: is there no rule for the meaſuring of depths?

Ma. It is all one with the meaſuring of heights. For the depth is nothing elſe but a rehearſed height. And therefore in the meaſuring of the depth of a thing, The Yard of your ſtaffe being parallele vnto the ſide of the thing, whoſe depth you meaſure, and your ſight paſſing from the toppe thereof: as the parts of the Tranſame cut off by the Yard, are to the parts of the Yard cut off by the Tranſame, ſo is the aſſigned length vnto the depth of the thing.

Sc. I perceiue your meaning. As for example: If the parts of the Tranſame be 5. and the partes of the Yard 13. and the diameter of the well (which is here in this example the aſſigned length) be 10. fæte long, the depth muſt be 26. fæte.

Ma. It is true, if you account from the top of your Staffe, and therefore that you may haue the iuſt depth of the thing, you muſt take away from the aforeſaid number as much as is aboue the thing meaſured: which if you ſuppoſe to be one fote in length, then is the well 25. fote dæpe, as appeareth in the fifth figure.

Sc. Thus much by the way concerning the meaſuring of any depth. What other rule haue you for the meaſuring of heights?

Ma. The firſt rule required that the Tranſame ſhould be perpendicular vnto the height propounded. The ſecond requireth the Yard to be perpendicular: as in the firſt figure: ſo that it differeth from the other onely in the manner of holding the Staffe. The rule is this: The yard of your Staffe being perpendicular vnto the thing meaſured as the parts of the yard are to the parts of the Tranſame, ſo is the aſſigned length vnto the height propounded to be meaſured.

Sc. So that I may conclude thus. If the parts of the Yard be 60. and the parts of the Tranſame 60. and the aſſigned length be 250. fæte: the height propounded muſt alſo be 250. fæte.

Ma. Your

Ma. Your conclusion is allowable: But I must put you in minde of this, to adde the allowance of your stature, which if you suppose to be 4. feete, then is the whole height 254. feete: Now marke this one thing for your further learning.

Sc. What is that?

Ma. By this meane you may finde out the seuerall partes of any height propounded: as in the seuenth figure you may finde out how many feete are contained betweene the top and the nether side of the window: or generally betweene any parts else, or placing as many Vanes vpon the Transame, as you would measure seuerall parts.

Sc. I must so place my Vanes, that from the end of the yard I may see each part propounded.

Ma. You say right, the rule then must be this: The Yard being perpendicular, as it was before vnto the height propounded, as the parts of the yard cut off by the Transame are vnto the distance of the Vanes, so is the whole height, vnto the part thereof propounded.

Sc. Let me shew that I vnderstand you, by propounding an example: I say, that if the partes of the Transame be 50. and the distaunce of the Vanes be 20. partes: and the whole height of the thing measured be 37. feete, then the part propounded must be 14. feete, and ⅖.

Ma. You vnderstand it well. And here is yet another thing to be noted: that if you know the length of any one peece of the thing whose height you desire to know, it is sufficient to bring you to the knowledge of the whole height, as in the 8. figure.

Sc. What rule haue you for that to direct me in the worke?

Ma. The Vanes of your staffe must be placed as they were before, namely, in such sort that your sight passing from the end of the yard by the Vanes, you may see both the ends of the part whose length you know. The rule then is this: that as the distance of the two Vanes is vnto the remnant of the Transame, downe vnto the yard, so is the part known vnto the remnant of the height propounded. So that if the distance of the Vanes

be 20. parts, and the remnant of the Transame from the nethermost Vane downeward be 30. parts: and the part of the height knowen be 14. feete, and $\frac{6}{5}$. I conclude the remnant of the height to be 22. feete, and $\frac{1}{5}$.

Sc. That standeth with reason, and may be proued by the example next going before this. For if the whole height were 37. feete, and the part propounded 14. feete, and $\frac{6}{5}$, that part being taken out of the whole, declareth the remnant to be 22. feete, and $\frac{1}{5}$.

Ma. The former two rules measured the height of a thing at one station. The third rule requireth a double station, as in the ninth figure. The rule is this: The Yard of your Staffe being perpendicular to the thing measured, as the difference of the two segments of the yard is to the distance betweene the two stations, so are the partes of the Transame cut off by the Yard to the height propounded.

Sc. What meane you by the difference of the two segments of the Yard?

Ma. You may easily know what that meaneth, by that which hath beene taught you before, in measuring the distance or length of a thing at two stations. Yet I will make it plaine vnto you here. When you make your first station, you know the Transame must cut the Yards in one place or other: also when you make your second station, the Transame must cut the Yard in another place, not the same which was before: the distance or parts of the Yard, contained betweene those two seuerall places, are called the difference of the segments.

Sc. In this case I must not moue my Transame vp and downe.

Ma. No, but you must moue it only either toward or from your sight.

Sc. When must it come toward my sight? and when must it goe farther from it?

Ma. That falleth out according to your seuerall stations. If in making your second station, you goe farther from the

thing measured, your Transome must goe farther from your sight: If you come nigher, your Transame also must come nigher your sight. And here I giue you warning againe, that you goe forward and backward in a right line, directly vppon the thing propounded.

Sc. Let me here also by example shew that I vnderstand your Rule. You say that as the difference betweene the two segments of the yard is vnto the distaunce betweene the two stations, so are the partes of the Transame vnto the heigth. Whereupon I conclude thus: that if the difference of the two segments be 23. and the distaunce of the two stations be 30. foote, and the parts of the Transame cut off by the yard be 44. then the heigth must be 57. foote, and $\frac{1}{23}$. as in the Figure.

Ma. Hitherto you haue learned how to measure the length and the height of things: now it followeth to measure the breadth.

Sc. Giue me leaue, I pray you, in this place to moue three questions: and first what meane you by the breadth?

Ma. The breadth here to be measured, is no more, then the length of the right line, conteyned betweene the two ends of the thing propounded, without any consideration of the roundnesse or hollownesse of the thing.

Sc. Secondly, how must I stand to hold my staffe?

Ma. You must stand so, that your staffe being applied vnto your eie, it may be perpendicular vnto the breadth propounded.

Sc. Last of all, when I purpose to measure the breadth of any thing, as of a wall, or such like, against which part of it must I stande against the iust middest of it? or against the one end? or else where I please, betweene the two endes? or without both the endes?

Ma. It is at your owne choise.

Sc. In measuring the former dimensions, my sight did passe but by one end of the Transame, must it do so likewise in this?

Ma. That is according as you stand to take the measure.

If you ſtand within the two ends of the thing propounded to be meaſured, your ſight muſt paſſe by the two ends of the Trãſame. If you ſtand againſt the one end of the thing, or cleane without it, your ſight paſſeth but by one end of the Tranſame.

Sc. What meane you here by the ends of the Tranſame? are they not here alſo to be taken as they were before?

Ma. Yes: The one end of the Tranſame muſt alwaies be that, where the partitions begin: the other end is that, vpon which the Vane muſt ſtand, and by which the ſight paſſeth. For many times it will ſo fall out that your ſight cannot paſſe by both the ends of the wood, ſo that you ſhall be enforced to place the Vane in ſome one part or other of the Tranſame, that it may be a limit for your ſight. And this is a generall rule, that if you ſtand within the ends of the breadth propounded, the one end of your Tranſame muſt be on the one ſide of the yard, and the other on the other ſide.

Sc. But will the yard be iuſt betweene them both?

Ma. No: Except your ſtation be made accordingly. If you ſtand in the middeſt of the thing to be meaſured, then will the yard be iuſt in the middeſt, betweene the endes of the Tranſame: if you ſtand more to the one end then to the other, the yard alſo will fall out in like manner, more toward the one end of the Tranſame, then toward the other.

Sc. How many waies are there to be vſed to meaſure the breadth by?

Ma. We may meaſure it two waies: either by the helpe of one ſtation, or of two.

Sc. If I meaſure it by the helpe of one ſtation, what muſt be knowen for the third proportionall number?

Ma. The diſtance betweene you and the thing propounded.

Sc. Put caſe that it be hollow inward betweene the two ends thereof: or ſwell outwardly: to which part muſt I then meaſure?

Ma. If it be conuexe, or round outward, the beſt way to meaſure the breadth is by two ſtations: but if it be hollow in-

ward

ward, you muſt meaſure no further then from your feet to the right line, which runneth betweene the two ends of the thing propounded.

Sc. What rule is there for the meaſuring of a breadth at one ſtation?

Ma. This. The Yard being perpendicular vnto the breadth aſſigned, as the parts of the Yard cut off by the Tranſame are vnto the partes of the Tranſame contained betweene the two ends, ſo is the diſtance betweene your feete and the thing meaſured, to the breadth thereof. As in the tenth figure.

Sc. I perceiue it well: For there are here two proportionall triangles cut in peces with a line in the midſt: Therefore as in the triangle A B C. the line B C. is to the line A C. ſo is the line B F. in the greater triangle to the line F G. which is the breadth of the wall. This dependeth vpon that which went before. Now what is your rule for the meaſuring at two ſtatiõs.

Ma. It is this: The Yard being perpendicular vnto the thing meaſured, & your ſight paſſing by the ends of the Tranſame (as it is required:) as the difference of the two ſegments of the yard is vnto the diſtaunce betweene the two ſtations, ſo are the parts of the Tranſame betweene the two ends thereof, vnto the breadth propounded: as it is in the 11. figure.

Sc. This alſo is very eaſie by reaſon of that which was taught before. So that I may conclude, that if the difference of the two ſegments in the yard be 10. parts: and the diſtance of my two ſtations be 40. fæte: and the parts betwæne the two ends of the Tranſame be 50. then muſt the breadth of the thing be 66. fæte and ⅔. Haue you any other thing to be added?

Ma. No: But that I would haue you to practiſe this diligently, and I will hereafter further you in other things.

Ma. I thanke you for it. Yet before I depart, I pray you let me aske you one queſtion: You ſaid before, that in meaſuring the breadth of any thing it is at my choiſe to ſtand where I will, either within the two ends of the thing to be meaſured, or againſt the one end thereof, or without both the endes, in

what place I shall thinke most expedient. This last kinde of measuring me thinketh is strange (as for the other I perceiue well enough how their proportion will fall out) wherefore I pray you helpe me herein.

Ma. Set the question as you shall thinke it best for your owne vnderstanding.

Sc. Put case I were to take the breadth of a riuer, as in the 12. figure, vnto whose brinke I can not come any nigher then 40. feete, by reason of some marish grounds adioyning thereunto: what meanes shall I vse to finde the breadth thereof?

Ma. You must goe thus to worke: (and as you do in this, so must you doe in all other things, without whose ends you bee inforced to stand when you take their breadth) chuse out vpon the riuers side two markes, as two trees, or such like things, standing one right against another.

Sc. But how must they stand in respect of the riuer?

Ma. Indeed that is a speciall thing to be noted: They must stand so, that the right line imagined to come from the two markes, may make a right angle with the riuers side: otherwise you shall erre in taking of your measure: Because that only is accounted the breadth of a thing, which maketh a right angle with the length.

Sc. Hauing chosen out these two markes, what is then to be done?

Ma. You must set vp another, which must stand also iust in one right line with the two first markes, whose distaunce from the mark on this side the riuer, must either be giuen you, as being already certainely knowne: or else it must be found out by the first rule concerning the measuring of breadths.

Sc. Put case I either know it, or finde it to be 40. feete.

Ma. You must chuse out a conuenient place, wherein you may make your station, & settle your selfe about your worke.

Sc. How must that place lie from the marke that was last set vp?

Ma. It must lie from it so, that the line drawne from that marke

marke vnto the place of your ſtanding, may make a right angle with the line drawne betweene the three aforenamed markes.

Sc. Muſt I not know the iuſt length betweene the place wherein I make my ſtation, and the marke which I ſet vp.

Ma. Yes: For it is the third proportionall number.

Sc. Imagine that diſtance to be 60. feete.

Ma. Then your rule to finde out the breadth is this: The Yard being perpendicular with the marke ſet vp, and your ſight paſſing from the head thereof by the end of the Tranſame vnto the marke ſtanding on the farther ſide of the riuer, as the parts of the Yard cut off by the Tranſame, are vnto the partes of the Tranſame cut off by the Yarde: ſo is the diſtaunce betweene your ſtation and the marke ſet vp vnto the diſtaunce betweene the ſayd marke, and the marke ſtanding vppon the further ſide of the riuer.

Sc. But what is this to the queſtion that I propounded? you make an aunſwere concerning the diſtaunce of the two markes, whereas I moued a queſtion of the breadth of the Riuer.

Ma. Be not angry, I will ſatisfie you ſtraight waies: firſt finde out the diſtance of theſe two markes.

Sc. That can I eaſily doe: For the parts of the yard being 30. and the parts of the Tranſame 36. and the diſtance of my ſtation from the firſt marke 60. feete. The firſt marke muſt be diſtant from the third 72. feete.

Ma. Then what is the breadth of the riuer?

Sc. That muſt come from you, for I cannot make the concluſion.

Ma. Then marke this. You ſayd the diſtaunce of the firſt marke from the third being on the farther ſide of the Riuer is 72. feete: and the diſtaunce of the firſt marke from the ſecond being on the hither ſide of the Riuer, was graunted to be 40. feete: then take 40. out of 72. and the remainder being 32. feete, declareth the breadth of the Riuer.

Sc. I perceiue now what a commodity it is to haue an instructor. For the thing which seemed vnto me most strange, and altogether impertinent to my question, is by your meanes made most evident vnto me, and greatly to the matter propounded. But must I take this course, whensoever I am driuen to stand without the compasse of the thing measured.

Ma. Yea, that you must: And sometimes also you shall be driuen to the second rule, wherein two stations are required, which soeuer you vse it commeth all vnto one purpose, and will easily afford you the breadth of a thing.

Sc. I can but thanke you for your paines, and good will, in accepting me for your scholler.

Ma. And I likewise you, for making choise of me to be your maister. My will is good to helpe whom I may; howsoeuer others may make more boast of their cunning.

FINIS.